are studied by them from the original protocols, furnished with a suitable explanatory text. Thus the fundamental elementary information is gained from the original sources before the lectures. The students are questioned concerning these fundamental experiments. The questions are arranged in the sequence required for a systematic presentation of the subject. Wherever necessary, the lecturer adds from his own stores to the information already possessed by the student. The class is encouraged to question the lecturer concerning matters not quite clear. At the close of the exercise the lecturer sums up briefly. The end in view is the development of the mind rather than the imparting of information. For example, the fact that the pressure of the saliva in the ducts of the submaxillary gland during secretion is higher than that of the blood in the carotid artery is not presented as a fact to be memorised, but is discussed with reference to its bearing on secretion by filtration; the student has learned the fact itself from the original source before coming to the lecture. Some of the lectures on special subjects, such as the eye, are given by distinguished specialists in practical medicine. Each instructor gives as an elective one or more lectures describing, with demonstrations, his own investigations; the investigator discussing his own experiments is a powerful intellectual stimulus; too little account has been taken of this educational force.

The student should be provided with what may be called a laboratory text-book. This text-book consists of a series of experiments and observations, taken from the original sources, and arranged in the sequence suited to develop the subject. Very often the historical sequence serves this purpose best. The description of the experiment follows the original so far as practicable. The experiments are provided with a suitable commentary text. The student is made to feel at every step that physiology is an experimental science, that the only material proper for discussion consists of observations and experiments free from error, and that safety demands constant reference to the original source. The laboratory text-book is supplemented by the student's laboratory note-book, in which the student preserves the graphic records of his experiments and the notes of his observations.

Little need be said concerning the instruction intermediate between the primary course and research. In the intermediate course the experiments chosen for the individual student vary with his goal, and are arranged in the order that seems best adapted to train the mind for research in the direction desired.

The methods of primary and advanced instruction here presented are obviously the methods of the investigator. They can be carried out effectively only by those whose chief purpose is the advancement of human welfare by discovery. In many schools, instructors are still selected mainly because they can talk agreeably of the work of others; in some, the instructor must have made one experimental study in the subject which he teaches; in a very few of the large schools, the higher positions are occasionally bestowed on men to whom research is more than a memory, but these positions almost invariably are burdened with a mass of petty administrative detail. The university devotes these men to researches which the university prevents them from making. Thereby its best minds are set to its lowest work. A change is necessary here. No man who has not made at least one experimental investigation should be appointed assistant in a department of physiology, no man who has not shown marked capacity for original work should be made instructor, and the professor's chair should be filled only by those in whom the ardour of discovery is not likely to be cooled by the advancing years. At least half the day should be set aside for research, and the hours thus reserved for the highest studies should be guarded against every encroachment. The best elementary instruction can be given only in the atmosphere of research. Discovery fires the imagination of youth, consoles the aged, and lifts the mind from mediocrity to greatness.

W. T. PORTER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the text of the speech (composed by Mr. A. C. Clark of Queen's College) delivered by Prof. Love in presenting Principal Lodge for the degree of D.Sc. *honoris causa* on February 12:—

Adest Oliverus Josephus Lodge, Naturæ rerum indagator acerrimus. Qui, ut vitam eius brevissime percurram, iam quinquaginta abhinc annos natus in Collegio Universitatis Londinensis primo institutus, in Universitate Londinensi gradum Doctoris Scientiæ adeptus est: mox in Collegio Universitatis de Liverpool Professor Physicæ creatus summa laude viginti annos floruit: anno denique proximo Universitatis novæ de Birmingham primus Præses factus est. Magna iamdudum fama inclaruit hic vir, quod in rebus physicis experimentorum longum ordinem peritissime commentus est et felicissime confecit: quo in genere sæpe numero ei contigit ut re acu tacta difficillimam aliquam quæstionem, in qua hæserant doctissimi Physicæ auctores, felicissime explicaret. Primo quidem quæ et qualis sit vis illa Naturæ moderatrix, quam ἐνέργειαν vocant, quibus mutationibus utatur, quærebat, neque laborum laude debita diu caruit a Regali Societate iam tredecim abhinc annos Sodalis electus. Iam tum vestigia Fitzgeraldiana secutus radiorum electricorum naturæ studere inceperat. Docuerat enim Maxwell, huius rei peritissimus, vim electricam oscillationibus quibusdam per inane spatium transferri posse, quo duce usi apud Germanos Hertzius, apud nostros Lodge, harum oscillationum signa et indicia certa deprehendere conabantur. Hertzium quidem ad metam primum pervenisse non nego, ad quam tamen Lodge eandem viam ingressus certo cursu ferebatur: illud vero affirmaverim veritate ab Hertzio patefacta hunc meliorem viam quærentibus monstravisse et novæ doctrinæ prædicatorem insignissimum exstitisse. Neque civium utilitatibus non inserviebant eius labores, cum in nuntiis arte telegraphica sine filo metallico mittendis, tum in fulminibus avertendis et in postes aeneos, tectorum nostrorum tutamina, sine fraude derivandis. His denique diebus magnam rem felicissime aggressus est cum quæreret de terræ cursu per medium illud ætherium, quo lux et vis omnis electrica et magnetica pervehitur, et doceret hoc medium, quod vocant, penitus stagnare et materiæ crassioris motibus omnino carere. Multum denique profecit in natura radiorum illorum explicanda quos Lenardus, Röntgen, Zeeman, viri acutissimi, primi detexerunt. Insignem eius operam in his variis generibus agnovit Universitas Sancti Andreaa, quæ gradu Legum Doctoris, et Regalis Societas quæ numismate aureo Rumfordiano eum iure ornavit.

Neque id silendum arbitror quod huic viro intima Naturæ penetralia reserare nequaquam satis erat, sed et in tironibus instituendis et in rebus gubernandis pari industria et felicitate eminuit: quo in genere haud parvam partem laudis suæ debet Universitas de Liverpool, de qua optime meritus est. Huius viri ingenio multiplici latior profecto campus iam datur, cum Universitatis novæ de Birmingham Præfectus sit.

The Junior Scientific Club held their 221st meeting on Friday, February 15. Mr. W. B. Croft, M.D., of Pembroke, read a paper on "The management of light waves," which was followed by a paper by Mr. A. C. Inman, of Wadham, entitled "René Descartes, and his physiology."

Mr. R. E. Baynes, Lee's Reader in Physics, has been appointed a delegate of the University Museum, in place of Sir John Conroy, F.R.S., deceased.

The Provost of Oriel (D. B. Munro) and the President of Trinity (H. F. Pelham) have been appointed representatives at the ninth Jubilee of the University of Glasgow.

CAMBRIDGE.—Mr. W. D. Niven, F.R.S., has been appointed an elector to the Cavendish professorship of experimental physics.

THE *American Naturalist* for January gives a list of gifts and bequests made to various educational institutes in the United States for eleven months of the year 1900, ending November 30; they amount to over sixteen million dollars. The largest amount is a gift, not to exceed three million dollars, from Mr. Andrew Carnegie, for the enlargement of the Carnegie Institute, Pittsburg, Pennsylvania. The number of gifts or bequests recorded is about eighty.

THE report of the Technical Education Committee of the Derbyshire County Council shows that continued progress is being made in the provision of adequate laboratory and workshop accommodation in important centres of the county. In the department of agriculture, the headquarters of the agricultural teaching have been transferred from Nottingham to the farm centre at Kingston, where additional buildings have been constructed to enable practical science work to be carried on.

THE Senate of the Royal University of Ireland has passed the following resolution:—"That in the opinion of the Senate the

relations of the University with its own colleges and students are unsatisfactory, and it is most desirable that a Royal Commission should be issued to inquire into the working of this University as an examining and teaching body in relation to the educational needs of the country at large, and to report as to the means by which University education in Ireland might receive a greater extension and be more efficiently conducted than it is at present."

AN influential committee, headed by the Duke of Devonshire, the Duke of Argyll, the Earl of Derby and Earl Spencer, have issued an appeal with the object of raising 150,000*l.* in celebration of the jubilee of Owens College, Manchester. Fifty thousand pounds are needed to discharge debts that have been contracted and 100,000*l.* for additional endowment. Among the objects the promoters have in view are the extinction of the debt of 22,000*l.* on the buildings of the medical school; special endowments for existing chairs, including chemistry, education, anatomy and philosophy; the establishment of an institution for bacteriological investigation and for the study of hygiene, and of research Fellowships; and the creation of a pension fund for members of the teaching staff.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xxiii. No. 1, January.—The new volume opens with a memoir by S. Kantor, entitled "Die Typen der linearen Complexe rationaler curven im R_n."—E. J. Wilczynski writes on transformation of systems of linear differential equations. It has been shown by Staeckel (*Crelle*, band 111) that the most general transformation, which converts a general homogeneous linear differential equation of order $m > 1$ into another of the same form and order, is

$$T : x = f(\xi),\ y = \phi(\xi)\eta,$$

where $f(\xi)$ and $\phi(\xi)$ are arbitrary functions of ξ. If $m = 1$ the most general transformation is

$$x = f(\xi),\ y = \phi(\xi)\eta^{\lambda}\ (\lambda \text{ a constant}).$$

The present paper considers a *system* of linear differential equations, and finds the most general transformation which converts such a system into a system of the same order. The transformation thus formed contains T as a special case. Staeckel's method is adopted in essence. The author is working at a theory of invariants of such systems, based on this general transformation.—Distribution of the ternary linear homogeneous substitutions in a Galois field into complete sets of conjugate substitutions, by L. E. Dickson, and the following paper, "Distribution of the quaternary linear homogeneous substitutions in a Galois field into complete sets of conjugate substitutions," by T. M. Putnam, are in continuation of a memoir by the former writer in vol. xxii. (pp. 121–137).—On the determination and solution of the metacyclic quintic equations with rational coefficients, by J. C. Glashan, is a tardy fulfilment of a promise made in vol. vi. p. 114.—E. O. Lovett contributes a construction of the geometry of Euclidean n-dimensional space by the theory of continuous groups.—A table of class numbers for cubic fields, by Legh W. Reid, is calculated with a view to furnishing for the general algebraic number fields an amount of number material sufficiently great to be of use in the further study of these fields, and in particular in that of the cubic fields. It gives for each of 161 cubic number fields the class number, h, the discriminant Δ, a basis, and the factorisation of certain rational primes into their prime ideal factors. The method is founded upon a theorem of Minkowski's. In every ideal class there is an ideal, j, whose norm, $n(\mathfrak{j})$, satisfies the condition

$$n(\mathfrak{j}) < \left(\frac{4}{\pi}\right)^{r} \frac{m!}{m^m} \left| \sqrt{\Delta} \right|,$$

where m is the degree and Δ the discriminant of the field, and r the number of pairs of imaginary fields found among the m conjugate fields, $k^{(1)}$, $k^{(2)}$, ... $k^{(m)}$. The writer refers to Hilbert, "Bericht über die Theorie der Algebraischen Zahlkörper"; Minkowski, "Geometrie der Zahlen," and Woronoj, "The algebraic integers, which are functions of a root of an equation of the third degree" (translation of Russian title). The tables take up ten pages.—On certain properties of the plane cubic curve in relation to the circular points at infinity, by R. A. Roberts, contains an investigation of some methods of generating a plane cubic curve.—With this opening number is presented an excellent portrait of Dr. George Salmon, and a supplement gives a still more excellent one of Prof. Mittag Leffler.—Prof. Frank Morley is the editor in chief.

Bulletin of the American Mathematical Society, January.—Prof. Lovett gives an account of the proceedings at the International Congress of Philosophy, which was held at Paris on August 1–5, 1900, and furnishes *résumés* of the papers read and the discussions occasioned by them, so far as they bore, more or less directly, upon mathematical questions. The sketch is founded upon the account printed in the September (1900) number of the *Revue de Métaphysique et de Morale*. It occupies pp. 157–183.—A demonstration of the impossibility of a triply asymptotic system of surfaces, by Dr. Eisenhart, was read before the Society on December 28, 1900. It is a notelet founded upon Bianchi's Lezioni.—Prof. E. W. Brown writes short notices of Berry's "Short History of Astronomy" and of H. Suter's "Die Mathematiker und Astronomen der Araber und ihre Werke." This latter, though only a catalogue of over five hundred names of mathematicians and astronomers, and so at first sight not giving promise of much interest, is really, as Prof. Brown shows, a work of considerable interest. He illustrates this statement by a few extracts.—There are a fair amount of notes and new publications.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, February 22.—Prof. S. P. Thompson, president, in the chair.—A paper on how air subjected to X-rays loses its discharging property, and how it discharges electricity, by Prof. Emilio Villari (Hon. Fellow), was read by the chairman. Air made active by X-rays in passing through a long tube coiled in many turns loses much more of its discharging power than it does in passing through the same tube if straight. During this process the tube charges itself to a certain potential. If active air is allowed to stream on masses of wire gauze or wound up ribbons, enclosed in tubes, the metals, independent of their nature, take a positive or negative charge according to whether the active air rubs against them with force or lightly. Experiments have been performed to prove this. For instance, tubes of copper or lead, if short and straight, take negative charges, but if long and coiled they take positive charges. These phenomena cannot be attributed to chemical actions, but seem to be produced by a special rubbing of the active air upon metallic surfaces, as the result of which they assume one of the charges, and the other charge ought to manifest itself in the air. This is not the case, the charge of the air being often of the same kind as that of the metals. It has previously been shown by the author that active air by streaming against an electrified body is reduced either to ordinary air or to air charged with the electricity which disappears. Hence it may be supposed that the active air in rubbing upon the metallic surfaces develops the two electricities, one of which manifests itself upon these surfaces, and the other goes to reduce the active air to ordinary air, and therefore does not become manifest. The electroscope used in the experiments consisted of a fixed brass plate and a gold leaf whose position was determined by means of a telescope with an eye-piece scale.—The chairman said he had observed the fact that metals were charged sometimes positively and sometimes negatively by active air. Mr. Watson asked if any experiments had been performed on the viscosity of gases rendered active by X-rays.—A paper on the propagation of cusped waves and their relation to the primary and secondary focal lines, by Prof. R. W. Wood, was read by Mr. Watson. This paper is a discussion of the reflexion of a plane wave by a hemispherical mirror, the reflected wave being likened to a volcanic cone. The cusp of the wave, or the rim of the crater, traces the caustic and is continuously passing through a focus. This accounts for the increased illumination along the caustic. The wave fronts were drawn by constructing the orthogonal surface, which in section is an epicycloid. The evolute of this curve is the caustic, and the reflected wave fronts form a family of parallel curves which are the involutes of the caustic. The wave front between two focal lines is expanding along one meridian and contracting along a meridian at right angles to it; in other words, the wave is convex along one meridian and concave along the other. The outer slope of the volcanic cone representing the reflected wave corresponds to the portion of the wave front between the focal